# Omar Alhussein

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## Education

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| Jan2016 - Apr2020 | **PhD in Communications and Information Systems (Electrical and Computer Engineering)**, University of Waterloo, ON, Canada |

Thesis:       On the Orchestration and Provisioning of NFV-enabled Multicast Services
Advised by:    Weihua Zhuang
GPA:           *89/100*
Notable courses: Stochastic processes, Intro to optimization, Wireless commun. networks.

**May2014 - Aug2015**    **MASc in Engineering Science**,
Simon Fraser University, BC, Canada
Thesis:       Performance Analysis of Wireless Fading Channels: A Unified Approach
Advised by:    Jie Liang, and Sami Muhaidat
GPA:           *4.22/4.33*
Notable courses: Machine learning, Linear systems theory, Advanced digital communications.

**Sep2008 - Aug2013**    **BSc in Telecommunication Engineering**,
Khalifa University, Abu Dhabi, United Arab Emirates
GPA:           *3.53/4.0* .

## Research Interests

### Applied Research

Network service and management, wireless networking and protocol design
mobile-edge and cloud computing

### Theoritical Research

Distributed learning, information-bottleneck theory, multi-agent reinforcement learning
explainable AI, semantic communications and learning.

## Work Experience

### Research

**Jun2020 - present**    **Senior Research Engineer, Advanced Networking Team**, *Huawei Technologies Canada*, Ottawa, Canada.
- Researching 6G and AI.
- Filed five patents on probabilistic and distributed AI for future networks, and on AI trustworthiness.
- One patent designated as high value patent, and another received a nomination.
- Received Quality Star Award for 2022.
- Received the highest Outstanding Individual Award for 2021.
- Received Director's Spotlight Award in Technology in April 2021.
- Received Ottawa Wireless Department Spotlight Award in August 2021.

**Jan2016 - Apr2020**    **Doctoral Research**, *University of Waterloo*, Waterloo, Canada.
- Developed a model-free data-driven method, using deep reinforcement learning, to compose and orchestrate abstract network services with time-varying traffic requirements onto the network substrate. A main result is using model-based solution with a vanilla DRL aids in the exploration process especially in conflicting and sparse reward environments.
- Developed an online competitive algorithm for multicast services with mandatory and best-effort NFs. The algorithm is designed using a primal-dual based approach, and it offers generalized and alternative description to existing relevant works. Results published in IEEE JSAC.
- Formulated an optimal joint traffic routing and NF placement for multicast services. Developed heuristic algorithm to decrease the complexity of the NP-hard problem. Published in IEEE JSAC and Globecom.
- Link to thesis: http://hdl.handle.net/10012/15850

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| May2014 - Aug2015 | **MASc Research**, *Simon Fraser University*, Vancouver, Canada. |
| | ○ Adopted two tractable mixture distributions, namely mixture of Gaussian and mixture of Gamma, to approximate various (composite) fading channels using the expectation-maximization and variational Bayes algorithms. |
| | ○ Conducted performance analyses over various composite fading channels (using the mixture distributions) in several environments, such as cognitive radio networks, and impulsive noise environments. |
| | ○ Results were published in seven conf/journal papers. |
| | ○ Link to thesis: http://summit.sfu.ca/item/15696 |
| Dec2013 - May2014 | **Research Assistant**, *Etisalat British Telecom Innovation Centre*, Abu Dhabi. |
| | ○ Developed a data reduction pre-processing technique for large datasets to be used in machine learning classifiers. Several papers were published. Was advised by Paul. D. Yoo & Kin Poon. |

## Teaching

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| Jan2018 - May2019 | **Graduate Teacher Assistant**, *University of Waterloo*, <br> Digital communications (ECE 318), and Communication networks (ECE 358). |
| Jan2015 - May2015 | **Graduate Teacher Assistant**, *Simon Fraser University*, <br> Introduction to engineering analysis (ENSC 180), and linear systems (ENSC 380). |
| Jan2010 - May2012 | **Science Communicator (part-time)**, *Khalifa University Intel Discovery Center*, Abu Dhabi. <br> Presented computing and communication technologies to stimulate/inspire school kids. |
| May2009 - Jun2009 | **Teacher assistant and supervisor**, *Institute of Applied Technology*, Abu Dhabi. <br> Served as a teacher assistant and supervisor in a summer school for primary school students. |

## Other

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| Jun2012 - Nov2012 | **Internship**, *ELKO TGS*, Ankara, Turkey. <br> Worked on the feasibility of initiating a SCADA communication system for the company. Through vulnerability assesment analysis, I was able to hack into R&D systems and sensitive control machines. Tasks included optimizing company's network and its security. |
| Jan2010 - May2013 | **Supervisor/invigilator (part-time)**, *IETLS Outreach Centre, British Council*, UAE. <br> Particpated in a mobile team to carry IELTS examinations in different places. Started off as a marshal and was promoted to invigilator and then supervisor in very short-time. |

## Current Supervision

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| Sep 2021 - present | Zaid Almahmoud, Deep Learning based Reconnaissance Techniques for Cyber Events, persuing Ph.D. at Birkbeck College, University of London. Co-supervision with Paul D. Yoo. |

## Patents

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| 6G, distributed ML | **O. Alhussein**, A. Akhavain, Communication-efficient training method for wireless split learning based network functions, *allowed internally - filing process*. |
| networking, distributed ML | **O. Alhussein**, M. Bhatti, and A. Akhavain, Adaptive encoding and decoding of information for network functions, Patent Corporation Treaty (PCT) Application 92012899PCT01, Nov. 18, 2022. *Nominated as high value patent.* |
| traffic engineering, distributed ML | **O. Alhussein**, Distributed network encoder-decoder system and method for traffic engineering, *United States Patent Application 92008480US01, Nov. 18, 2022.* |
| traffic engineering, Bayesian DL | **O. Alhussein**, and A. Akhavain, Methods and Apparatus for Managing Network Traffic Via Uncertainty, United States Patent Application 17/568,893, Jan. 5, 2022. |
| DRL, privacy, AI Trustworthiness | **O. Alhussein**, and P. Ashwood-smith, Methods, Systems, and Computer Program Products for Protecting a Deep Reinforcement Learning Agent, United States Patent Application 17/546,768, Sep. 12, 2021. *Designated as high-value patent.* |
| | Note: Some patents will be published as conference/journal papers in 2023. |

## Manuscripts under review

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| cyber security, AI | Z. Almahmoud, Paul D. Yoo, and **O. Alhussein**, A holistic and proactive approach to forecasting cyber threats, *submitted to Nature Communications*. |

## Peer-reviewed Publications

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|---|---|
| NFV, DRL | **O. Alhussein**, and W. Zhuang, "Dynamic Topology Design of NFV-enabled Services using deep Reinforcement learning," IEEE Transactions on Cognitive Communications and Networking, to appear. DOI: 10.1109/TCCN.2021.3139632 |
| performance analysis | M. Li, S. Huang, L. Tian, **O. Alhussein** and S. Muhaidat, "Error rate performance of NOMA system with full-duplex cooperative relaying," Physical Comm., pp. 1-1, 2021. |
| trust management, network security | M. Ben-Yahya, **O. Alhussein**, and X. Shen, "Securing software-defined WSNs Communication via trust Management," IEEE Internet of Things J., pp. 1–1, 2021. |
| NFV, online algorithms | **O. Alhussein**, and W. Zhuang, "Robust online composition, routing and NF placement for NFV-enabled services," IEEE J. Sel. Areas Commun., vol. 38, no. 6, pp. 1089–1101, 2020. |
| NFV, multicast routing | **O. Alhussein**, P. T. Do, J. Li, W. Shi, W. Zhuang, and X. Shen, "A Virtual network customization framework for multicast services in NFV-Enabled core networks," IEEE J. Sel. Areas Commun., vol. 38, no. 6, pp. 1025–1039, 2020. |
| ML, subsampling | **O. Alhussein**, P. D. Yoo, S. Muhaidat, J. Liang, "Efficient subsampling framework of very large datasets in machine learning," in Proc. IEEE CCECE, 2019, pp. 1-6. |
| spectrum sensing | M. Li, **O. Alhussein**, P. Sofotasios, S. Muhaidat, P. D. Yoo, J. Liang, and A. Wang, "Censor-based cooperative multi-antenna spectrum sensing with imperfect reporting channels," IEEE Trans. Sustainable Comput., vol. 05, no. 01, pp. 48-60, 2019. |
| NFV, multicast routing | **O. Alhussein**, P. T. Do, J. Li, Q. Ye, W. Shi, W. Zhuang, X. Shen, X. Li, and J. Rao "Joint VNF placement and multicast traffic routing in 5G core networks," in Proc. IEEE GLOBECOM, 2018, pp. 1-6. |
| mixture distributions, algorithms | M. Wahbah, **O. Alhussein**, et al., "Evaluation of parametric statistical models for wind speed probability density estimation," in IEEE Proc. EPEC, 2018, pp. 1-6. |
| SDN, space-air-ground networks | N. Zhang, S. Zhang, P. Yang, **O. Alhussein**, W. Zhuang, and X. Shen, "Software defined space-air-ground integrated vehicular networks: Challenges and solutions," IEEE Comm. Magazine, vol. 55, no. 7, pp. 101–109, 2017. |
| impulsive noise, generalized fading | **O. Alhussein**, I. Ahmed, J. Liang, S. Muhaidat. "Unified analysis of diversity reception in the presence of impulsive noise," IEEE Trans. Vehicul. Technol., vol. 66, no. 2, pp. 1408–1417, 2017. |
| cooperative spectrum sensing | A. Al Hammadi, **O. Alhussein**, P. C. Sofotasios, S. Muhaidat, M. Al-Qutayri, S. Al-Araji, G. K. Karagiannidis, and J. Liang, "Unified Analysis of cooperative spectrum sensing over composite and generalized fading channels," IEEE Trans. Vehicul. Techn., vol. 65, no. 9, pp. 6949–6961, 2016. |
| ML, intrusion detection | O. Al-Jarrah, **O. Alhussein**, P. D. Yoo, S. Muhaidat, K. Taha, and K. Kim, "Data randomization and cluster-based partitioning for botnet intrusion detection," IEEE Tran. Cybern., vol. 46, no. 8, pp. 1796–1806, 2016. |
| approximation techniques, performance analysis | B. Selim, **O. Alhussein**, S. Muhaidat, G. K. Karagiannidis, and J. Liang, "Modeling and analysis of wireless channels via the mixture of gaussian distribution," IEEE Trans. Vehicul. Techn., vol. 65, no. 10, pp. 8309–8321, 2016. |
| ML, security | R. Baiad, **O. Alhussein**, H. Otrok, and S. Muhaidat, "Novel cross layer detection schemes to detect blackhole attack against QoS-OLSR protocol in VANET," Vehicular Communin., vol. 5, pp. 9–17, 2016. |
| Mixture gamma, diversity analysis | **O. Alhussein**, A. Hammadi, P. C. Sofotasios, S. Muhaidat, J. Liang, M. Alqutayri, G. K. Karagiannidis, "Performance analysis of energy detection over mixture gamma based fading channels with diversity reception," in Proc. IEEE Wimob, 2015, pp. 399–405. |
| ML | F. Adly, **O. Alhussein**, P. D. Yoo, S. Muhaidat, and Y. Al-Hammadi, "Simplified subspaced regression network for identification of defect patterns in semiconductor wafer maps," IEEE Trans. Ind. Informat., vol. 11, no. 6, pp. 1267–1276, 2015. |
| mixture Gaussian model | **O. Alhussein**, B. Selim, T. Assaf, S. Muhaidat, G. K. Karagiannidis, and J. Liang, "A generalized mixture of gaussians for fading channels," In Proc. IEEE VTC, 2015, pp. 1–6. |
| spectrum sensing, fading | B. Selim, **O. Alhussein**, G. K. Karagiannidis, and S. Muhaidat, "Optimal cooperative spectrum sensing over composite fading channels," in Proc. IEEE ICC, 2015, pp. 520–525. |
| EM, fading | **O. Alhussein**, S. Muhaidat, J. Liang, and P. D. Yoo, "A unified approach for representing wireless channels using EM-based finite mixture of gamma distributions," in Proc. Globecom Workshops, 2014, pp. 1008–1013. |
| OFDM, SDR | **O. Alhussein**, R. Mahmoud, K. Eledlebi, and Z. Sead, "Spectrum sensing techniques for OFDM-based cognitive radio networks," in Terena Netw. Conf., 2013, *Indexed poster*. |

ML  K. Alromaithi, **O. Alhussein**, and P. D. Yoo, "An intelligent system for protein structure prediction," in Undergraduate Research Conf. Applied Comput., Zayed University, 2012, *Poster*.

S. Azzeh, **O. Alhussain**, and S. A. Abusamra, "A mathematical model to decrease obesity in the UAE," in Proc. ASME IMECE, 2011, pp. 385-390.

## Technical Skills

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| Sim. & Math | Tensorflow, Matlab, Mathematica, R, Propsim F32, Weka |
| Programming | Python, C++, Git |
| Networking | Mininet, Kubernetes, Wireshark, NMAP, OpenFlow |

## Pedagogical Training

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| May2021 - Sep2021 | Passed an online course from the University of Hong Kong on the fundamentals of university teaching. |
| 2019-2020 | Attended six seminars at the University of Waterloo that covered various topics: (a) teaching methods, (b) effective lesson plans, (c) classroom delivery skills, (d) student's beliefs about learning, and (e) providing quality feedback. |

## Honors and Awards

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| 2021 | Awarded Outstanding Individual Award for the year 2021, Huawei Technologies Canada. |
| Aug2021 | Awarded Wireless Department Spotlight Award in Huawei Technologies Canada, Ottawa. |
| Apr2021 | Awarded Director Spotlight Award in Huawei Technologies Canada, Ottawa. |
| Sep2019 | Awarded University of Waterloo Graduate Scholarship ($1500). |
| Sep2019 | Awarded Xuemin Shen graduate scholarship in communications ($1000). |
| May2019 | Awarded University of Waterloo Graduate Scholarship ($1500). |
| Jan2016 | Awarded faculty of engineering graduate scholarship, University of Waterloo ($1500). |
| Jan2014 - Aug2015 | Awarded graduate fellowship, Simon Fraser University ($6250). |
| Sep2008 - Aug2013 | Awarded full undergraduate scholarship, Khalifa University ($172,822). |
| May2012 | Won first place at the ASME rapid design challenge, District J. Development Conference at the Lebanese American University. |
| 2009-2011 | Represented school at gulf/national programming contests (NPC2009, NPC2010, GPC2011). |
| 2010–2010 | Won first place at university competitive programming contest, Khalifa University. |
| 2010–2010 | Won second place at the engineering design competition, IEEE-UAE Student Day. |

## Service

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| 2022-present | Associate Editor for Peer-to-Peer Networking and Applications Springer Journal. |
| 2022-2022 | TPC member for Proc. IEEE VTC and Globecom |
| 2018-2021 | TPC member for Proc. IEEE CommNet. |
| 2013-present | Regular Reviewer for IEEE Commun. Lett., IEEE Tran. Veh. Techn., IEEE Proc. Globecom, & many other journals and conferences. |
| 2010–2012 | Vice Chair, IEEE Student Chapter, Khalifa University. |
| 2010–2011 | Engineering Section Editor, Student Voice Newsletter, Khalifa University. |

## Other Interests

Swimming and Free-diving (Licensed AIDA-2, personal record: 3m45s static apnea).

Traveling (mostly occasional weekend escapades, and event travels).